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Comparison of Phototactic Behavior of Three Populations of Dropsophila melanogaster

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COMPARISON OF PHOTOTACTIC BEHAVIOR OF THREE POPULATIONS OF DROPSOPHILA MELANOGASTER

ABSTRACT—Phototactic response of three distinct breeding populations of *Drosophila melanogaster* are compared through experimental maze runs and under differing light stimuli. While it is suggested that more meaningful results may depend on intensified selection pressure and studies of a greater number of generations, evidence from these observations indicates a clear differnece in photo tactic behavior between the fly population drawn from laboratory stock subject to in-breeding and the positive responses of the two populations captured "wild" and thus reflecting the selection process of nature.

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Experiments by Hirsch (1958) and Hadler(1964) have shown that phototactic behavior is genetically influenced in Drosophila melanogaster and that this phototactic behavior can be enhanced by selective breeding. Dobzhansky (1967) in his work with Drosophila has estimated the heritability of the polygenic phototactic behavior between 8 and 10 percent.

The experiment reported here compared the phototactic responses of three distinct breeding populations of Drosophila melanogaster. One population, the "Minnesota flies," was a laboratory stock. The other two were natural populations captured in St. Petersburg and Pigeon Key, Florida.

The "Minnesota flies" were obtained from the genetics laboratory at St. Olaf College, Northfield, Minnesota, and were considered to be rather inbred and therefore not very heterogeneous genetically. Greater genetic variances would be expected in the less inbred natural populations of "Pigeon Key flies" and "St. Petersburg flies".

This experiment also included selection for positive and negative phototactic behavior in all three populations.

The subjects

The "St. Petersburg flies" were captured between December 30 and January 2, 1975. The "Pigeon Key flies" were captured between January 9-12, 1975.

To capture these flies, small slices of banana were placed in paper cups and the cups were placed outdoors. Each morning and afternoon a piece of clear plastic film was placed over each cup to trap any flies , and the average catch would be 3 or 4 flies per cup.

All captured flies were then relaesed into a clear plastic bag. A small vial containing fruit fly medium was inserted into the opening of the bag, with the plastic being held tightly around the vial. The vial was then worked up slowly to the top of the bag, where the flies could be worked into the vial. Once the flies were inside, the vial was capped and the flies were left to breed.

*ROSS S. ANDERSON conducted the experiment reported here while at St. Olaf College, Northfield, Minnesota.

The apparatus

A branching T-maze was used to measure the phototactic responses of the fly populations. 30 L (Amoco No. Hw2122) and 15 T (Amoco No. Hw41222) plastic pipe fittings were used to connect light and dark half-inch plastic tubing which was used for the pathways.(Fig. 1) A random number table was to be dark.(odd number—left= dark, even number—right=dark)

Two 150 watt lights were placed 50 cm. away at a height of 35 cm. on either side of the maze.

At the end of each pathway a vial containing medium was held in place by a circular sponge. This medium (36 gms. agar/1750 cc water, 250 cc light Karo syrup, 250 cc dry cornmeal/10 gms. yeast extract/500 cc water, 16 cc tegasept) was an attractant for the flies.

A 500 cc syringe with the top cut off was used to introduce the flies into the maze.

The maze run

The flies were slightly etherized, and equal numbers of males and females were placed into the syringe. After the flies had recovered and were moving, approximately 10 minutes, they were introduced into the first T maze. The plunger of the syringe was only used to encourage those flies which remained in the syringe after several hours.

Maze trials were 24 hours in duration, each beginning at approximately 3:30 p.m., to control for the diurnal behavior in Drosophila (Benzer 1973). The flies were run at room temperature, 21 degrees C.

To complete the maze and to get to the vial of medium at the end, each fly had to travel a distance of 85 cm. and make four choices between light or dark pathways. After 24 hours, the bottles were removed and the bottle identification number and the number of males and females in that bottle were recorded

There are 16 possible pathways in this maze, and each one is assigned a light score value from 1 to 5. The light score is determined by the number of turns toward the light in that pathway. A score of 1 means no turns to the light.

There is only one possible pathway to get a light score of either 1 or 5. There are four pathways to get a light score of 2 or 4. There are 6 pathways to get a light score of 3.

The mean light score for the population is computed by summing the number of flies times the light score value of the bottle and dividing by the total number of flies which completed the maze.

The selection

Selection also was made for positive and negative phototactic behavior in the three populations. For the selection part of this experiment, those flies which scored either 1 or 5 for a light score were placed in vials for 48 hours, during which time any fertilized eggs would be deposited. The flies were then transferred into another bottle to propagate.

When the F1 developed, they were run through the maze, just as the parents had been , and their light score was compared with that of the parents.

Results from completed runs

Of the number of flies which were introduced into the maze, approximatley 50 percent completed the run and some interesting results were obtained from the completions.

Graph No. 1 compares the light score distributions for the three populations and gives the mean light score value and the variance.

The "Minnesota flies" show a normal distribution curve. The mean light score of 2.92 with a variance of .69 seems to indicate that there was no clear trend of light or dark choice among these flies.

The "Pigeon Key flies" and the "St. Petersburg flies", which were caught wild, showed a definite trend toward the light, "Pigeon Key flies" having a mean light score of 4.16 with a variance of 1.2, and the "St. Petersburg flies" having a mean light score of 3.92 with a variance of 1.4.

The "Minnesota flies", having been inbred for many gnerations would be expected to be more homozygous than the two natural populations and therefore would show less genetic variance. It would be expected then, that if this behavior was genetically influenced, the "Minnesota flies" would show a smaller variance from the mean than the natural populations.

A comparison of the variance shows that the natural populations have variances approximately twice as great as the Minnesota variance.

In the selection experiments done by Dobzhansky (1967), flies were selected for 29 generations with a much more rigid selection pressure, 15light/dark choices compared with four in this study.

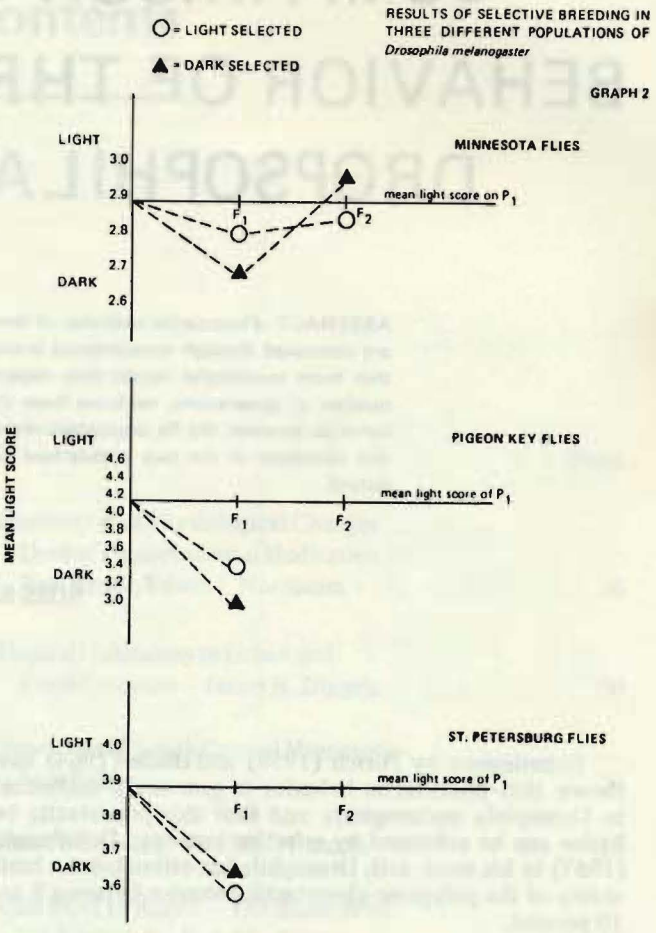
To get meaningful results from this maze, selection pressure would have to be increased along with an increse in the number of generations run.

Different response to identical procedures

Hadler (1964) mentions fourteen environmental variables that will affect to some degree the phototactic response of Drosophila: genetic background of the tested population, temperature during the test, time of day of test, time since anesthetic, rearing conditions, mechanical stimulation, time since feeding, energy and wavelenght of light, sate of dark adaption, number of observations or trials per individual, age and sex.

TABLE 1

BOTTLE	LIGHT TURNS	LIGHT SCORE n+1
1	1	2
2	2	3
3	0	1
4	1	2
5	1	2
6	2	3
7	3	4
8	2	3
9	4	5
10	3	4
11	3	4
12	2	3
13	2	3
14	1	2
15	2	3
16	3	4



In the present experiment there was clearly a difference between the phototactic behaviors of the laboratory flies and the natural flies since the procedure followed for the three runs identical, this difference is due to something other than technique.

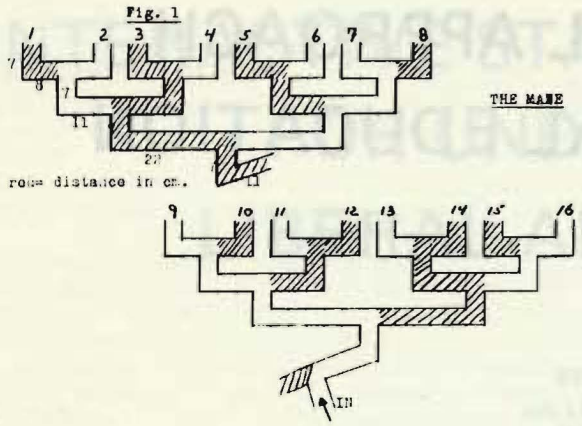
A possible explanation for this difference in behavior is that positive phototaxis is selected for in nature and that such selection does not play as large a role in laboratory conditions.

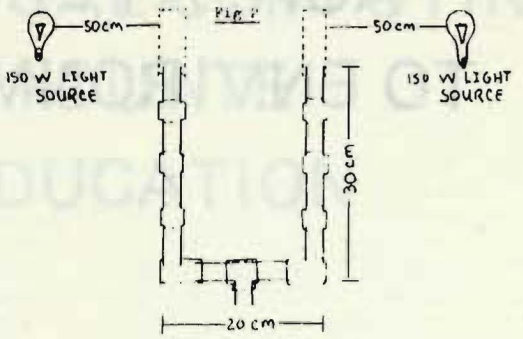
Two functions which are critical for the survival of Drosophila are: obtaining food and reproduction.

The fly that senses food and travels toward the dark is more likely to become buried or trapped or stuck than the fly which travels toward light in search of food. This would not be the case in the laboratory where the food is readily available.

Secondly, observations on the mating behaviors on many hundreds of individual Drosophila indicate that visual stimuli constitute a major factor in the initiation of courtship (Sturtevant 1915). Behaviors such as vibrating, flicking, waving, and fluttering the wings play a role in the courtship of Drosophila.

Therfore, those flies which seek the light should have a better chance of finding a mate than those which seek the dark. Again this would not be as great a factor in the laboratory, where the flies are confined in a small space.





In these two ways positive phototaxis would be selected for in nature.

Extrapolations from fruit fly to man are obviously hazardous, but the research under way with Drosophila concerning polygenic traits such as phototaxis can be important in helping to construct models which can throw at least some light on the polygenic traits in man.

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DATA

	Minnesota	Pigeon Key	St. Petersburg
Parents			
Mean light score	2.92	4.16	3.92
Variance	.69	1.19	1.39
Number run	920	970	720
Number completed Males/females	190/182	258/166	148/121
Percent completion	44%	47%	40%
F_1 **Light Selected**			
Mean light score	2.79	3.44	3.60
Variance	.68	1.35	1.22
Number run	368	500	420
Number completed Males/females	155/126	195/149	121/43
Percent completion	77%	70%	43%
F_1 **Dark Selected**			
Mean light score	2.70	3.04	3.67
Variance	.99	1.23	1.21
Number run	426	500	220
Number completed Males/females	136/156	177/96	63/16
Percent completion	69%	55%	37%
F_2 **Light Selected**			
Mean light score	2.87		
Variance	1.12		
Number run	500		
Number completed Males/females	32/7		
Percent completion	8%		
F_2 **Dark Selected**			
Mean light score	2.95		
Variance	.86		
Number run	670		
Number compelted Males/females	192/157		
Percent completion	56%		